LECTURE 1

- GO OVER SYLLABUS & PROJECT
- GRADES DISTRIBUTION → WEB ASSIGN, → I-CLICKER
  - 2049C MEANS TOGETHER WITH LAB
    - MISSING 3 LABS W/O EXCUSES MEANS FAILING LAB
    - MISSING 4 LABS W/O EXCUSES MEANS FAILING ENTIRE COURSE!

[illegible]

MATERIALS COVERED

~~ELECTRIC FIELD~~ ELECTRICITY
- ELECTRIC FIELDS
- GAUSS'S LAW
- ELECTRIC POTENTIAL
- CAPACITANCE / DIELECTRICS
- CURRENT + RESISTANCE

MAGNETISM CH 29 – 32

AC CURRENT CH 33

EM WAVES CH 34

CH 23, 24, 25, VERY DIFFICULT

26 OK.

27 - 28 EASY

29 - 32 ~~EA~~ VERY DIFFICULT

33, 34 NOT SO BAD

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1. DO PROBLEMS AT THE END OF CHAPTER
2. READ TEXT BOOKS : PAY ATTENTION TO EXAMPLES
3. ASK QUESTIONS + STOP LECTURES
4. COME TO OFFICE HOURS

WHAT IS THE POINT OF TAKING PHYSICS?

HOW IS IT DIFFERENT FROM 2048?

POLO BALL DEMO

DEMO EM 318

324 TWO KINDS OF CHARGES

GREEKS RUBBED AMBER WITH WOOL ⇒ AMBER ATTRACTED THINGS

600 B.C.

BEN FRANKLIN 1706 - 1790 CHARGES + AND —

<u>ELECTRIC CHARGE</u>

ATOMS MAKE UP THE WORLD

ELECTRONS $m_e = 9.109 \times 10^{-31}$ kg

PROTONS $m_p = 1.673 \times 10^{-27}$ kg

NEUTRONS $m_n = 1.675 \times 10^{-27}$ kg

CONDUCTORS AND INSULATORS

DEFINITION

CHARGES CAN MOVE FREELY ON CONDUCTORS

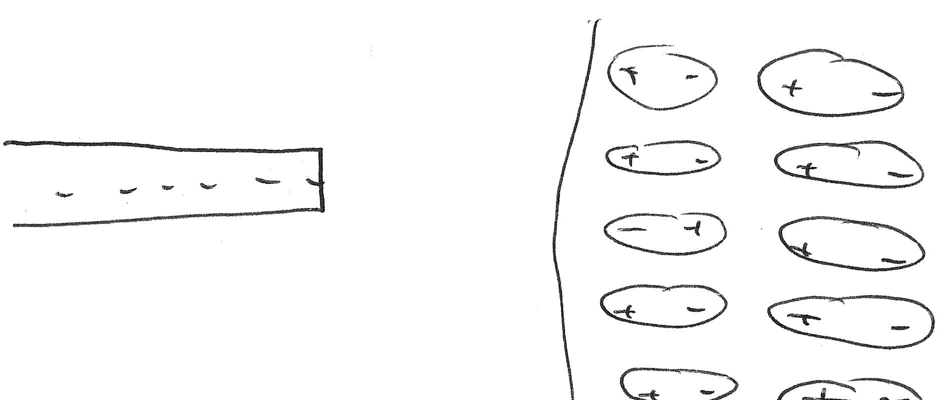
CONDUCTORS : COPPER

INSULATORS : DIAMONDS

CHARGING BY INDUCTION : METAL ROD

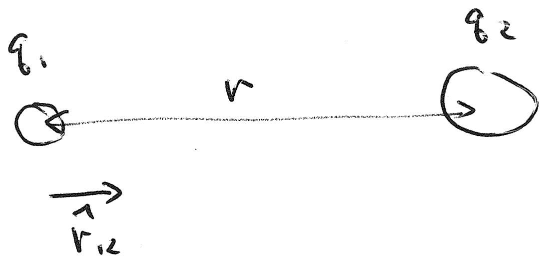
EM 338

EM 340



PUT THIS UP ON
BOARD FIRST

COULOMB'S LAW



$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2} \hat{r}_{12}$$

FORCE ON 2 BY 1

IF q_1, q_2 HAVE THE SAME SIGN REPELS

$\varepsilon_0 = 8.854 \times 10^{-12}\ C^2/N \cdot m$ (PERMITTIVITY OF FREE SPACE)

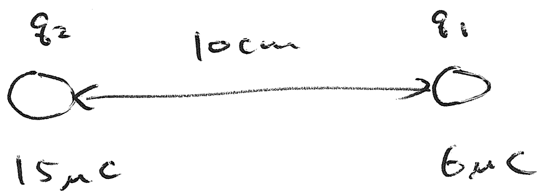
C: COULOMB UNIT FOR CHARGE

ELECTRON

$e: -1.6 \times 10^{-19}\ C$

$p: 1.6 \times 10^{-19}\ C$

EXAMPLE



$r = 0.1\ m$

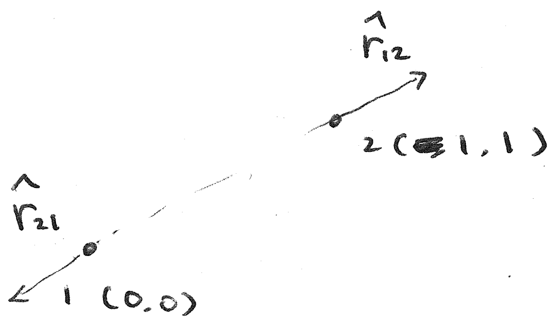
$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\cdot m^2$

$$|\vec{F}| = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$= \frac{1}{4 \cdot 3.14 \times 8.85 \times 10^{-12}\ C^2/N\cdot m^2} \cdot \frac{(15 \times 10^{-6}\ C)(6 \times 10^{-6}\ C)}{(0.1\ m)^2}$$

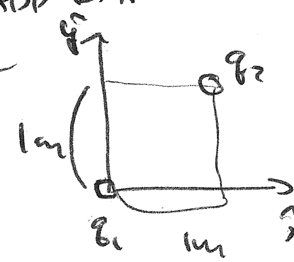
$$\cong \frac{1}{12 \times 9 \times 10^{-12}\ C^2/N\cdot m^2} \cdot \frac{90 \times 10^{-12}\ C^2}{0.01\ m^2} \sim \underline{100\ N}$$

2. WHAT IS $\hat{r}_{12}$?

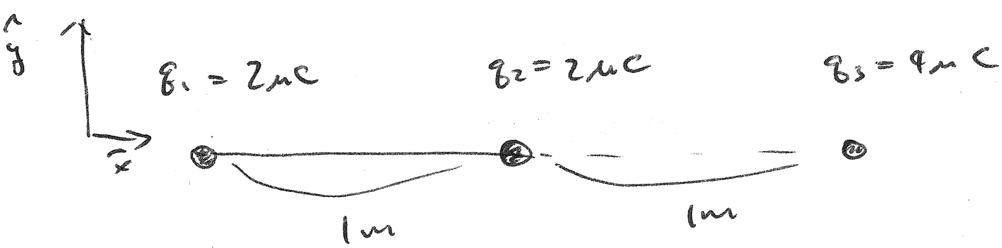


$$\hat{r}_{12} = \frac{(1,\ 1)}{\sqrt{2}} \quad \text{OR} \quad \frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$$

ADD EXAMPLE



SEE TWO PAGES LATER



WHAT IS $\vec{F}_3$?

$$\vec{F}_3 = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{(2m)^2}\hat{r}_{13} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{(1m)^2}\hat{r}_{12}$$

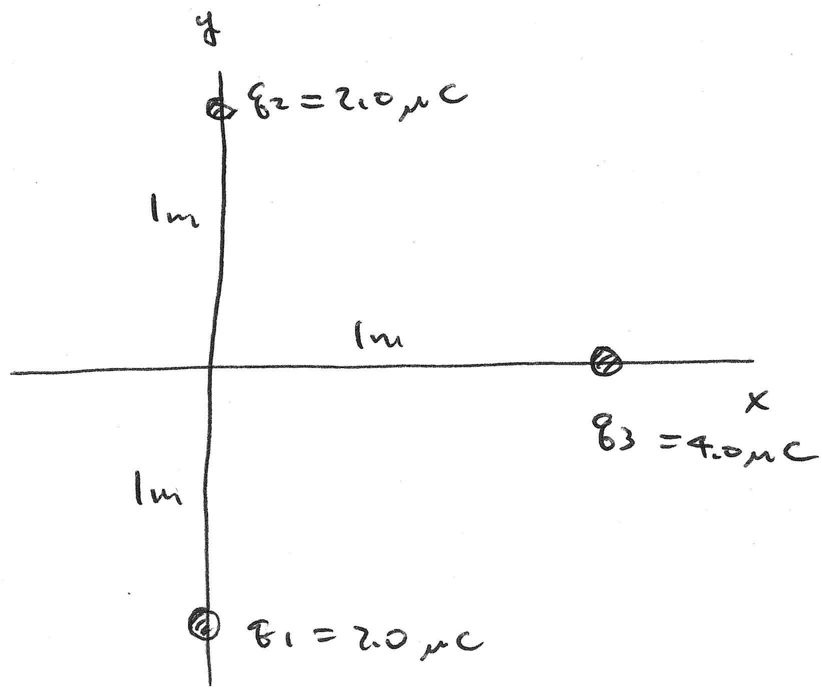
$$\hat{r}_{13} = \hat{x} \qquad \hat{r}_{12} = \hat{x}$$

$$= \frac{1}{4\pi\varepsilon_0}\left[\frac{(2\times10^{-6}C)\cdot(4\times10^{-6}C)}{4m^2} + \frac{(2.0\times10^{-6}C)(4.0\times10^{-6}C)}{1m^2}\right]$$

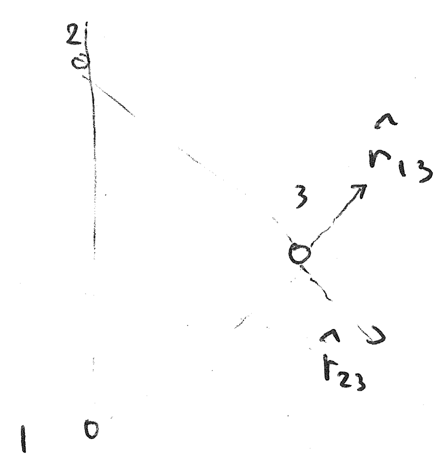
$\Rightarrow$ JUST NEED TO CALCULATE THIS

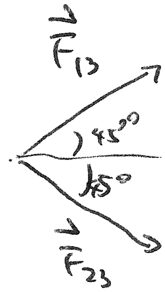
FORCES ADDING: LAW OF SUPER POSITION

LAW OF SUPER POSITION #2



WHAT IS THE FORCE ON CHARGE 3?





$|\vec{F}_{13}| = |\vec{F}_{23}|$

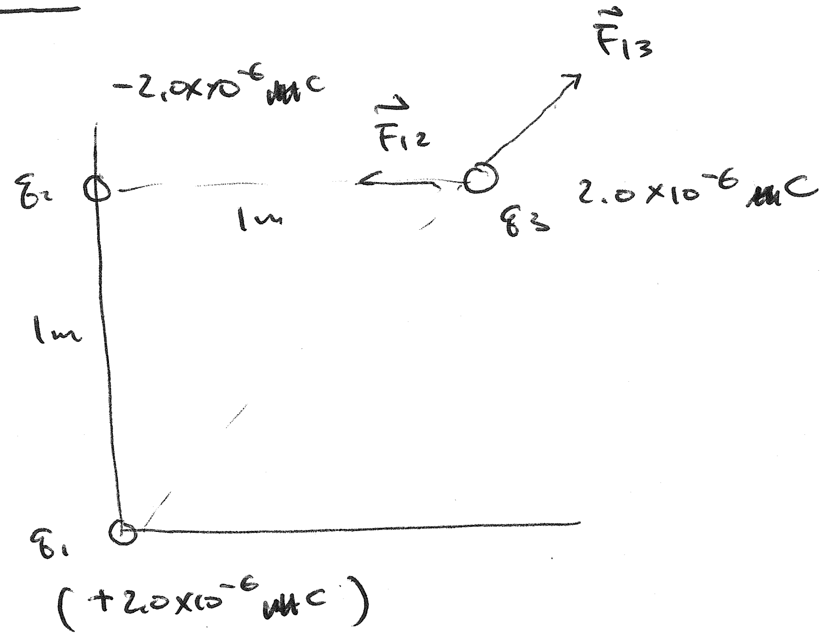
SINCE $q_1 = q_2$

$|\vec{r}_{13}| = |\vec{r}_{23}|$

∴ RESULTANT FORCE

$$\left[\, |\vec{F}_{13}| \cos 45^\circ + |\vec{F}_{23}| \cos 45^\circ \,\right] \hat{i}$$

EXAMPLE #3



$$\vec{F}_{13} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_3}{|r_{13}|^2}\hat{r}_{13}$$

$$= 8.99\times10^{9}\ N\text{-}m^2/C^2 \quad \frac{4.0\times10^{-12}}{(\sqrt{2})^2}\hat{r}_{13}$$

$$= \frac{3.6\times10^{-2}}{2}\hat{r}_{13} = 1.8\times10^{-2}\ \hat{r}_{13}\ N$$

$$\hat{r}_{13} = \frac{(1,1)}{\sqrt{2}} \qquad \vec{F}_{13} = 1.8\times10^{-2} * \frac{(1,1)}{\sqrt{2}}\ \hat{r}_{13}$$

$$\vec{F}_{12} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{|r_{12}|^2} = 8.99\times10^{9}\ N\text{-}m^2/C^2 \ \frac{-4.0\times10^{-12}}{(1m)^2}\hat{r}_{12}$$

$$= -3.6\times10^{-2}\ N\ (1,0)$$

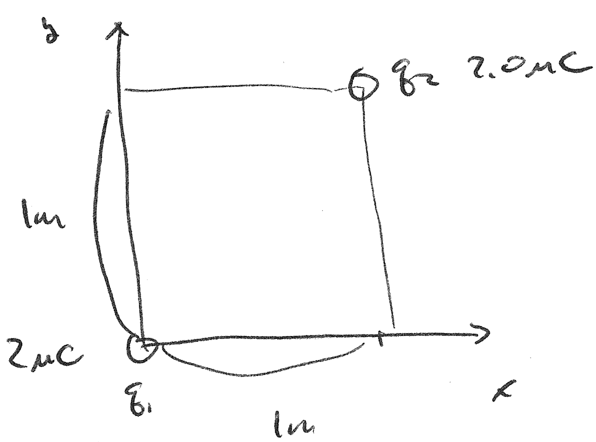
$\vec{F}_{12} + \vec{F}_{13} =$ ~~[scribbled out]~~

$$-3.6\times10^{-2}\,(1,0) + 1.8\times10^{-2}\,\frac{(1,1)}{\sqrt{2}}\ \text{N}$$

= JUST ADD

⇓

$$\left(-3.6\times10^{-2} + \frac{1.8\times10^{-2}}{\sqrt{2}},\ \frac{1.8\times10^{-2}}{\sqrt{2}}\right)\text{N}$$



$$\hat{r}_{12} = \frac{(1,1)}{\sqrt{2}}$$

$$|\hat{r}_{12}| = 1$$

OR

$$\hat{r}_{12} = (\sin 45^\circ,\ \cos 45^\circ)$$ (~~cos 45°, sin~~)

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{(2\mu C)(2\mu C)}{(\sqrt{2})^2}$$

$$\frac{1}{4\pi\varepsilon_0} = 8.99\times10^{9}\ \text{N}\cdot\text{m}^2/\text{C}^2$$

2×10^{-12}

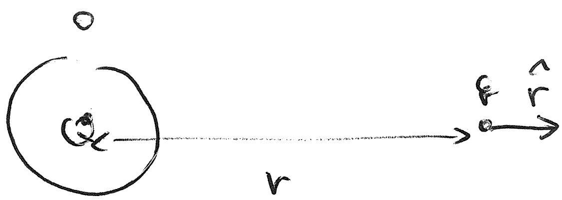
$$= \frac{1}{4\pi\varepsilon_0}\frac{4\times10^{-12}\ \text{C}^2}{2\ \text{m}^2} = 8.99\times10^{9}\ \text{N}\cdot\text{m}^2/\text{C}^2\ \frac{\text{C}^2}{\text{m}^2}$$

$$= 1.8\times10^{-2}\ \text{N}\ \underline{(1,1)}$$

DEMO HERE

ELECTRIC FIELD

DEFINITION

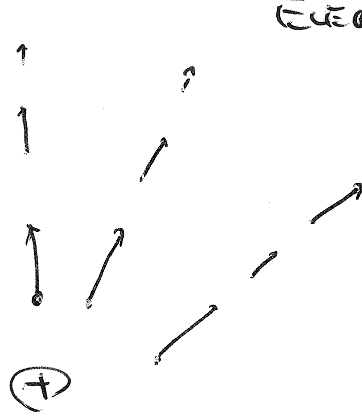


$$\vec{F}_q = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}\hat{r}$$

$$\vec{F}_q = \vec{E}q \Rightarrow \vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

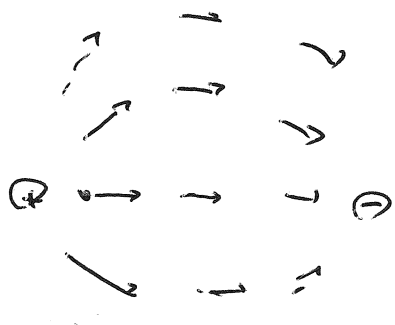
ELECTRIC FIELD

N/C

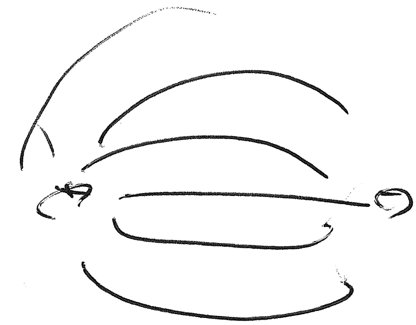


AND SO ON

(ELECTRON IN A UNIFORM FIELD)

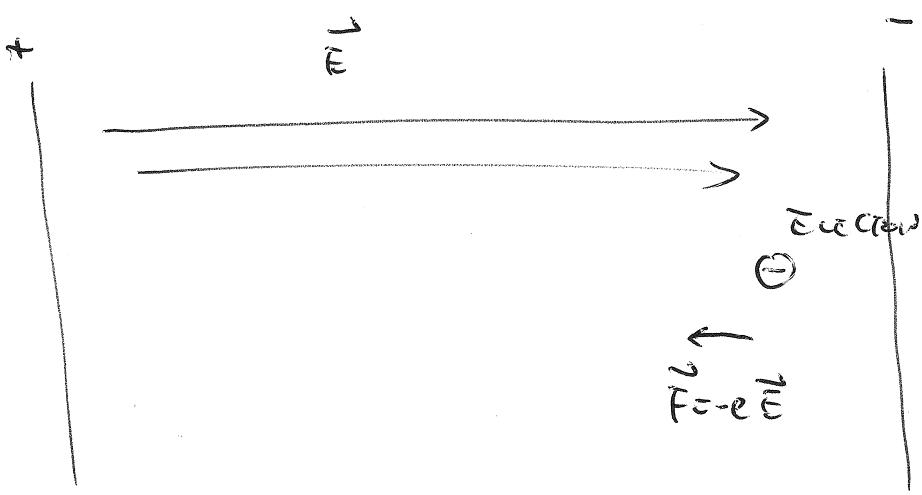


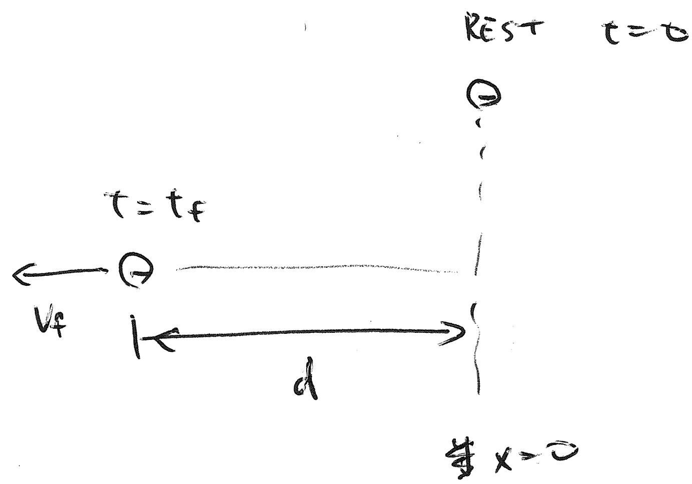
"FIELD LINES"



DEMO

ELECTRON IN A UNIFORM FIELD





V_f?

$$\vec{F} = -e\vec{E}$$

$$\vec{F} = m\vec{a} = -e\vec{E}$$

$$a = -\frac{eE}{m}$$

$$v = -\frac{qE}{m}t$$

$$x = -\frac{qE}{2m}t^2$$

$$d = \frac{qE}{2m}t_f^2 \qquad t_f = \sqrt{\frac{2md}{qE}}$$

$$V_f = -\frac{qE}{m}\sqrt{\frac{2md}{qE}} = -\sqrt{\frac{qE}{m}}\sqrt{2d}$$

KINETIC OF ELECTRON AT t_f?
ENERGY AT

$$K.E. = \frac{1}{2} m v_f^2 = \frac{1}{2} \cancel{m} \frac{qE}{\cancel{m}} \cancel{2} d$$

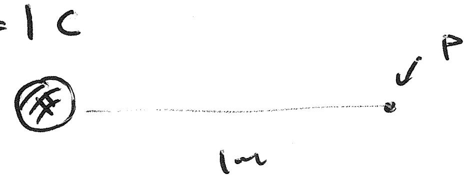
$$(K.E._f) = qEd$$

SIMILAR TO

$$\underline{mgd}$$

CALCULATING $\vec{E}$

$Q = 1\,C$



$\vec{E}_p$?

$$\vec{E}_p = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} = \frac{1}{4\pi\varepsilon_0} \frac{1\,C}{(1\,m)^2}$$

$$= \frac{1\,C}{4\pi\, 8.85\times10^{-12}\ C^2/N\,m^2 \cdot m^2}$$

$$= 0.008\,99 \times 10^{12}$$

$$\simeq 9\times10^{9}\ N/C$$